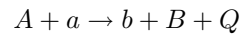


Kinematics Calculation

A(a,b)B reaction



energy conservation

$$E_1 + Q = E_3 + E_4$$

momentum conservation

$$\begin{aligned} m_1 v_1 &= m_3 v_3 \cos \theta + m_4 v_4 \cos \psi \\ 0 &= m_3 v_3 \sin \theta - m_4 v_4 \sin \psi \end{aligned}$$

where

$$\begin{aligned} E_3 &= \frac{1}{2} m_3 v_3^2 \\ E_4 &= \frac{1}{2} m_4 v_4^2 + \text{Ex} \quad \text{Ex: Excited Energy} \end{aligned}$$

calculation

$$\begin{aligned} \frac{1}{2} m_1 v_1^2 + Q - \text{Ex} &= \frac{1}{2} m_3 v_3^2 + \frac{1}{2} m_4 v_4^2 \\ m_4^2 v_4^2 &= (m_1 v_1 - m_3 v_3 \cos \theta)^2 + (m_3 v_3 \sin \theta)^2 \\ m_4 \times (E_1 + Q - \text{Ex}) &= \frac{1}{2} m_3 m_4 v_3^2 + \frac{1}{2} (m_1^2 v_1^2 - 2 m_1 v_1 m_3 v_3 \cos \theta + m_3^2 v_3^2) \end{aligned}$$

$$A v_3^2 - 2 B v_3 + C = 0$$

where

$$\begin{aligned} A &= m_3(m_3 + m_4) \\ B &= m_1 v_1 m_3 \cos \theta \\ C &= m_1^2 v_1^2 - 2 m_4 (E_1 + Q - \text{Ex}) \end{aligned}$$

$$v_3 = \frac{B \pm \sqrt{B^2 - AC}}{A}$$

after all

$$E_3 = \frac{1}{2} m_3 v_3^2$$

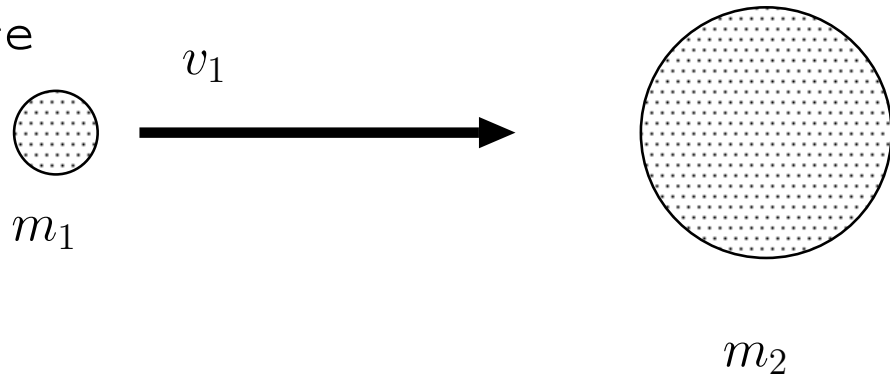
the sign plus or minus, check the energy conservation

$$E_1 + Q = \frac{1}{2} m_4 v_4^2 + \text{Ex} + E_3$$

where

$$\frac{1}{2}m_4v_4^2 = \frac{1}{2m_4}(2m_1E_1 + 2m_3E_3) - \frac{\sqrt{2m_1E_1}\sqrt{2m_2E_2}}{m_4}\cos\theta$$

before



after

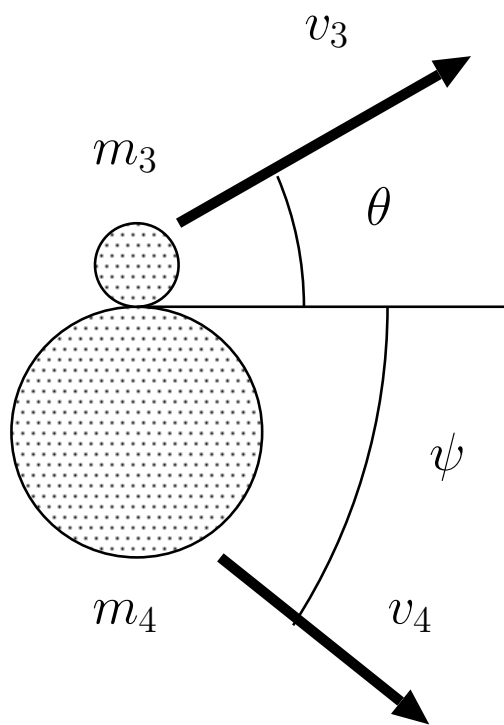


Fig.0.1 A(a,b)B